Announcements

- Homework for tomorrow…

  (Ch. 26, CQ 12, Probs. 16, 18, & 22)

  CQ3: $E_3 = E_4 > E_2 > E_1$

  26.8: See handout

  26.36: $E = \frac{1}{4\pi\epsilon_0}\frac{4\lambda y}{(y^2 + (d/2)^2)}$

- Office hours…

  MW 10-11 am

  TR 9-10 am

  F 12-1 pm

- Tutorial Learning Center (TLC) hours:

  MTWR 8-6 pm

  F 8-11 am, 2-5 pm

  Su 1-5 pm

Chapter 26

The Electric Field

(*The Parallel-Plate Capacitor & Motion of a charged particle in an E-field*)

Last time...

- *E*-field of a *ring* of radius *R* & charge *Q* on the *z*-axis..

$$\boxed{E_{ring} = \frac{1}{4\pi\epsilon_0}\frac{Qz}{(z^2+R^2)^{3/2}}}$$

- *E*-field of a *disk* of radius *R* & charge *Q* on the *z*-axis..

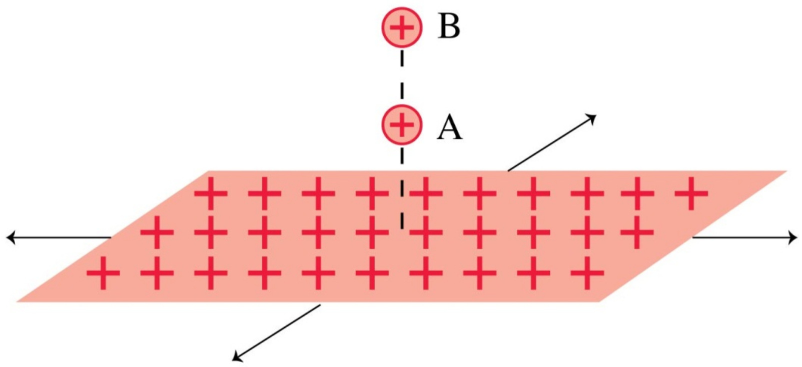
$$\boxed{E_{disk} = \frac{\eta}{2\epsilon_0}\left[1 - \frac{z}{\sqrt{z^2+R^2}}\right]}$$

- *E*-field of an *infinite plane*...

$$\boxed{E_{plane} = \frac{\eta}{2\epsilon_0}}$$

Quiz Question 1

Two protons, *A* and *B*, are next to an infinite plane of positive charge. Proton *B* is *twice* as far from the plane as proton *A*. Which proton has the larger acceleration?



1. Proton *A*.
2. Proton *B*.
3. Both protons have the same acceleration.

Quiz Question 2

At the dot, the *y*-component of the *E*-field due to the shaded region of charge is

1. $$\frac{(Q/L)\,dx}{4\pi\epsilon_0(x^2+y^2)} \times \frac{y}{x}$$

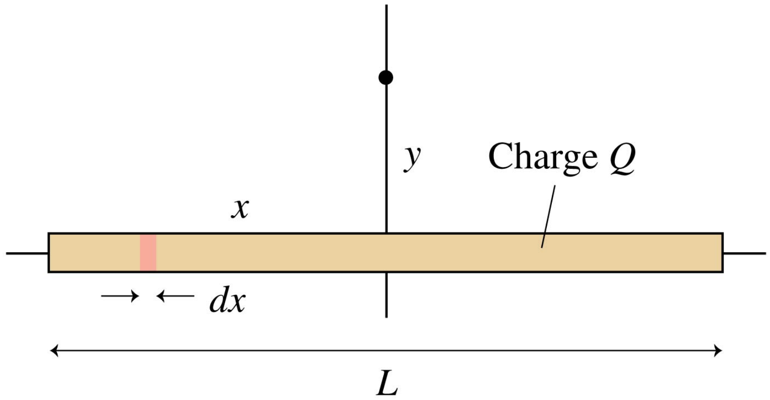
2. $$\frac{(Q/L)\,dx}{4\pi\epsilon_0(x^2+y^2)} \times \frac{x}{y}$$

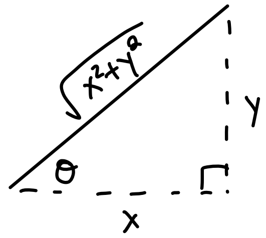
3. $$\frac{(Q/L)\,dx}{4\pi\epsilon_0(x^2+y^2)} \times \frac{x}{\sqrt{x^2+y^2}}$$

4. $$\frac{(Q/L)\,dx}{4\pi\epsilon_0(x^2+y^2)} \times \frac{y}{\sqrt{x^2+y^2}}$$

5. $$\frac{(Q/L)\,dx}{4\pi\epsilon_0\sqrt{x^2+y^2}} \times \frac{y}{\sqrt{x^2+y^2}}$$

F $\qquad$ $\sin\theta$



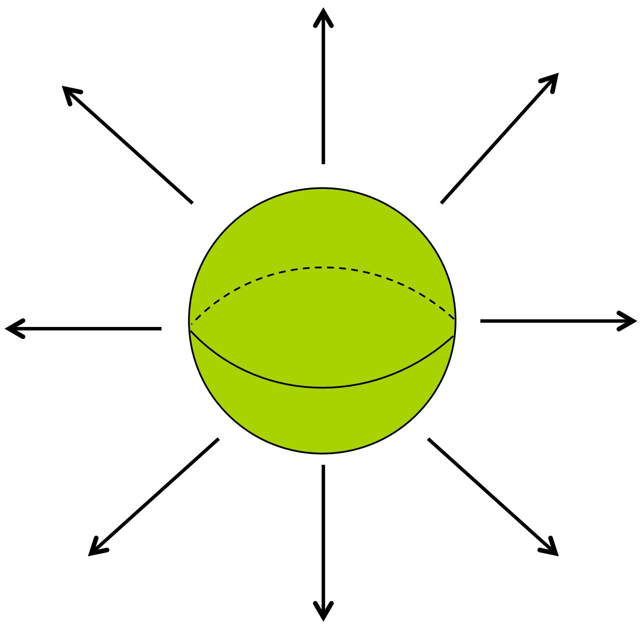


$E_y = E\sin\theta$

$\sin\theta = \frac{y}{\sqrt{x^2+y}}$

E-field of a sphere..

A sphere of charge Q and radius R (uniformly charged or a spherical shell) has an E-field of the form…



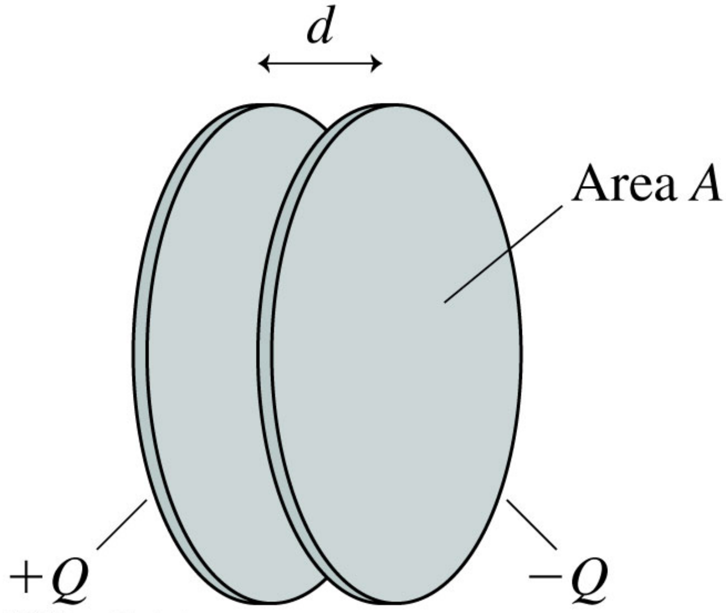
$$\boxed{E_{sphere} = \frac{1}{4\pi\epsilon_0}\frac{Q}{r^2} \quad \text{for } r \geq R}$$

$E_{Sphere} = \frac{KQ}{r^2} \quad r \geq R$

- *Exactly* the same as that of a point charge!

26.5: The Parallel-Plate Capacitor

Two electrodes, one with charge $+Q$ and the other with $-Q$, placed face-to-face a distance d apart..

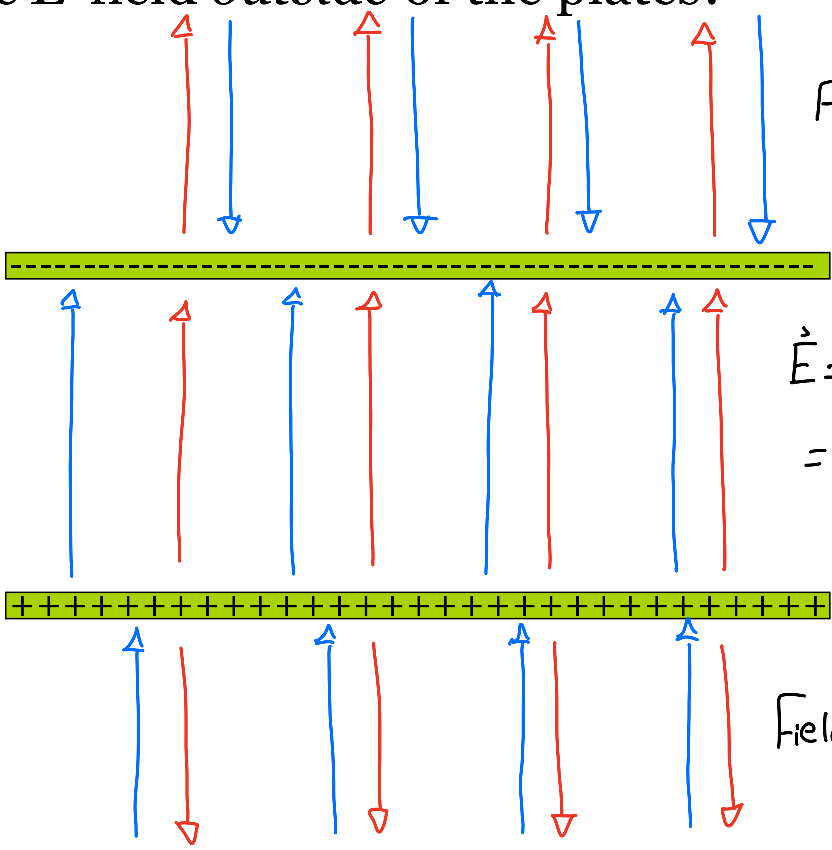


The Parallel-Plate Capacitor

- What's the *E*-field *between* the plates?

- What's the *E*-field *outside* of the plates?

Field = 0



$$\vec{E} = \vec{E}_+ + \vec{E}_- = \frac{\eta}{2\epsilon_0} + \frac{\eta}{2\epsilon_0} = \frac{\eta}{\epsilon_0}\hat{j}$$

Field = 0

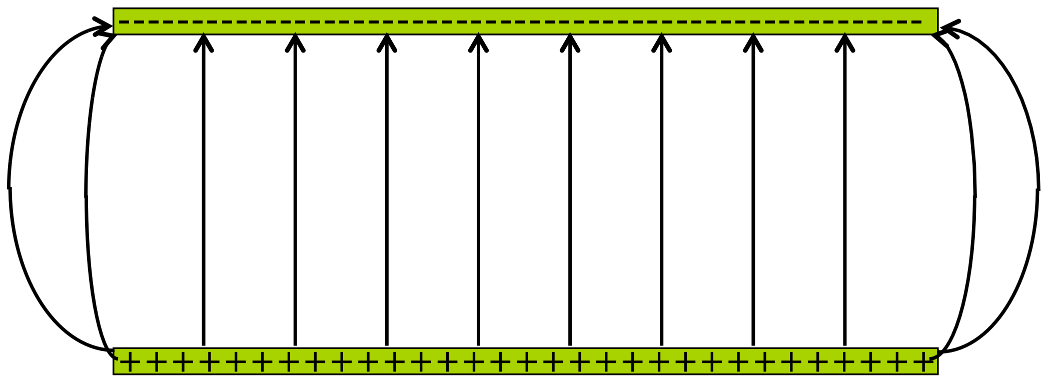
The Parallel-Plate Capacitor

- What's the *E*-field *between* the plates?

$$\boxed{\vec{E}_{capacitor} = \frac{\eta}{\epsilon_0}}, \quad \text{from + to -}$$

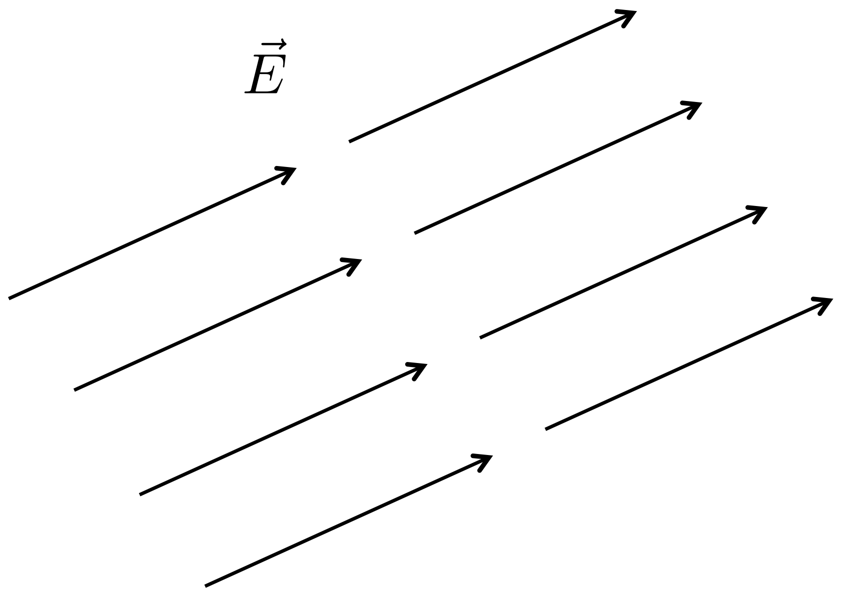
- What's the *E*-field *outside* of the plates?

$$\boxed{\vec{E}_{capacitor} = \vec{0}}$$



Uniform E-Field…

- is the *same* in *magnitude* and *direction* at every point in space.
- Parallel-plate capacitors produce *uniform E*-fields



26.6:
Motion of a Charged Particle in an *E*-Field

- The *E*-field exerts a force on a charged particle…

$$\vec{F}_{onq} = q\vec{E}$$

- If it's the *only* force acting on q, then…

$$\vec{F}_{net} = q\vec{E} = m\vec{a}$$

$\vec{F} = q\vec{E}$ $\quad$ $\vec{F} = m\vec{a}$

- If it's a uniform *E*-field, then…

$$a = \frac{qE}{m} = \text{constant}$$

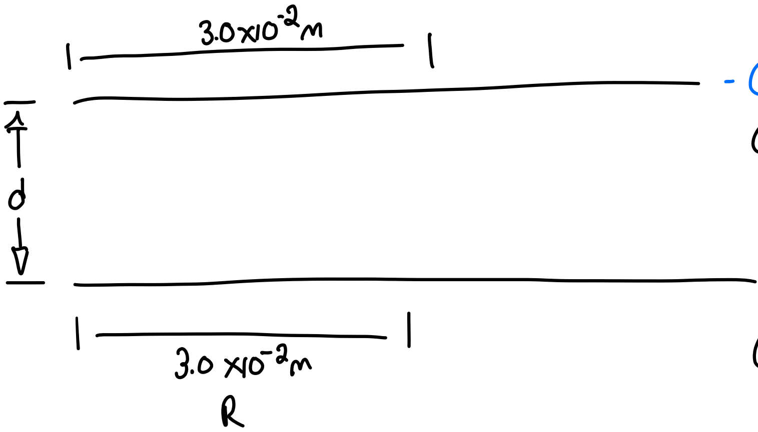
i.e. 26.8:
An e^- moving across a capacitor

Two 6.0 cm diameter electrodes are spaced 5.0 mm apart. They are charged by transferring 1.0 x 10^{11} e^-s from one electrode to the other. An e^- is released from rest at the surface of the negative electrode.

How long does it take the e^- to cross to the positive electrode?

What is its speed as it collides with the positive electrode? Assume the space between the electrodes is vacuum.

26.8



$-Q = (1.0\times10^{11})(1.6\times10^{-19}\,C)$

$Q = 1.6\times10^{-8}\,C$

$= -1.6\times10^{-8}\,C$

$+Q$

$Q = 1.6\times10^{8}\,C$

$A = \pi r^2$

$\eta = \dfrac{Q}{A}$

$= \dfrac{1.6\times10^{-8}\,C}{\pi(3.0\times10^{-2}\,m)^2} = 5.7\times10^{-6}\,C/m^2$

$= \dfrac{5.7\times10^{-6}\,C/m^2}{8.85\times10^{-12}\,C^2/Nm^2}$

$= 6.4\times10^{5}\,N/C$

$\Sigma F = ma$

$qE = ma$

$a = \dfrac{qE}{m}$

$a = 1.1\times10^{7}\,m/s^2$